Editorial for the Special Issue on Robust and Reliable Power Electronics

AS power electronic systems are gradually gaining more and more important status in a wide range of applications, their reliability has become an important issue for the manufacturers. In recent years, the automotive and aerospace industries have brought more stringent reliability constraints on power electronic systems, because of safety requirements but also because such systems becomes much more electrified. The industrial and energy sectors are also following the same trend, and a lot of efforts are being devoted to improving power electronic systems in order to account for reliability with cost-effective combined with sustainable solutions. A paradigm shift in reliability research and engineering in power electronics is going on in terms of the design methodologies, reliability testing concepts, and robustness validation approaches [1], [2] and Fig. 1 illustrates the important aspects of modern reliability engineering in power electronics, which need to be mastered for future products.

Research on active switching devices, passive components, and interconnections is of high interest in order to have a better understanding on the component-level reliability physics and this is naturally extended to system-level reliability based on component level reliability physics. Furthermore, with the consideration of reliability as performance, the existing or new power converter topologies and control schemes need to be studied in multi-physics domains to optimize their design. Further on fault-tolerant design and prognostic health management are also interesting research areas to provide additional opportunities to ensure the reliable field operation of power electronic systems, especially in reliability-critical applications. However, the more easy interconnection – eg. IoT will make such things commodity in almost all kind of products. At the same time emerging technologies like GaN and SiC devices call constantly for new life time models, new test methods to understand the devices fully as well as doing better integration in order to keep the pace and launch strong products to a power electronics market, which is booming for the moment as a part of making the society more sustainable.

The purpose of this Special Issue is to review the state-of-the-artin the Robust and Reliable Power Electronics fields and to disseminate the recent advancements in Reliability Engineering and how to approach it from device to systems. It is my believe this field is one of the very emerging topics in the next decade and it needs a very multidisciplinary efforts to achieve the goal.

This Special Issue on Robust and Reliable Power Electronics has collected 3 papers from basic reliability engineering to more system engineering in terms of control and operation.

The first paper entitled "Enhancing PV Inverter Reliability with Battery System Control Strategy" is written by Dr. Ariya Sangwongwanich and colleagues from Aalborg University (Denmark) and colleagues from RWTH Aachen (Germany) where different operation, and control strategies for a photovoltaic (PV) system also having a battery energy storage system are discussed. It is a system engineering paper and the analysis shows that with a proper control of the battery-PV system much higher reliability can be achieved for the grid connected converter.

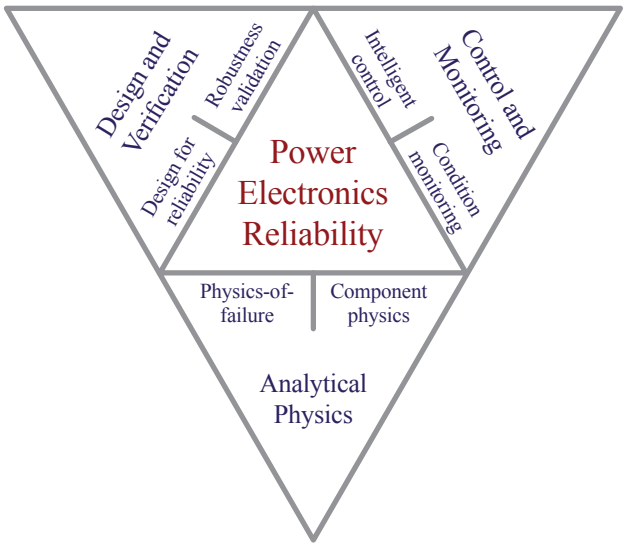

Fig. 1. Main areas in modern reliability engineering in power electronics – from components to control and monitoring of products in the field.

The second paper is authored by Dr. Alessandro Soldati and his colleagues from University of Parma (Italy) and it has the title of "Electric-vehicle Power Converters Model-based Design for Reliability". This paper is proposing a design for reliability approach in EV's where they are especially studying different driving cycles impact on the thermal aging of the power electronic devices. They are also discussing how active thermal control in the drive train can increase the expected life time on the power electronics. Further – the variation of the components are treated in order to take a statistical approach for the analysis.

The third paper on "Analysis of Electromagnetic Transient Characteristics of Doubly-fed Induction Generator Under Grid Voltage Swell" is contributed by Mr. Yonghong Deng and his colleagues from China University of Petroleum (China) and it is dealing with the control issues of a DFIG-based wind turbine system when transients are occurring in the grid – if they are not properly handled failure will occur in the wind turbine system and thereby having poor reliability. Both simulations and experimental results are provided to support the theory presented.

I would like to express thanks to the guest associate editors for their efforts spend of this special issue making 3 good papers as well as I wish to thank the time spend from the expert reviewers, who have provided comments and input to the assessment and scoring of the submitted manuscripts.

Further Reading

[1] H. Wang, M. Liserre, F. Blaabjerg, P. P. Rimmen, J. B. Jacobsen, T. Kvisgaard, J. Landkildehus, "Transitioning to physics-of-failure as a reliability driver in power electronics," *IEEE Journal of Emerging and Selected Topics in Power Electronics,* vol. 2, no. 1, pp. 97-114, 2014

[2] K. Ma, H. Wang and F. Blaabjerg, "New approaches to reliability assessment: Using physics-of-failure for prediction and design in power electronics systems," *IEEE Power Electronics Magazine,* vol. 3, no. 4, pp. 28-41, Dec. 2016.

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Frede Blaabjerg was with ABB-Scandia, Randers, Denmark, from 1987 to 1988. From 1988 to 1992, he got the Ph.D. degree in Electrical Engineering at Aalborg University in 1995. He became an Assistant Professor in 1992, an Associate Professor in 1996, and a Full Professor of power electronics and drives in 1998. From 2017 he became a Villum Investigator. He is honoris causa at University Politehnica Timisoara (UPT), Romania and Tallinn Technical University (TTU) in Estonia.

His current research interests include power electronics and its applications such as in wind turbines, PV systems, reliability, harmonics and adjustable speed drives. He has published more than 500 journal papers in the fields of power electronics and its applications. He is the co-author of four monographs and editor of 9 books in power electronics and its applications.

He has received 28 IEEE Prize Paper Awards, the IEEE PELS Distinguished Service Award in 2009, the EPE-PEMC Council Award in 2010, the IEEE William E. Newell Power Electronics Award 2014 and the Villum Kann Rasmussen Research Award 2014. He was the Editor-in-Chief of the *IEEE Transactions on Power Eelectronics* from 2006 to 2012. He has been Distinguished Lecturer for the IEEE Power Electronics Society from 2005 to 2007 and for the IEEE Industry Applications Society from 2010 to 2011 as well as 2017 to 2018. In 2018 he is President Elect of IEEE Power Electronics Society.

He is nominated in 2014, 2015, 2016 and 2017 by Thomson Reuters to be between the most 250 cited researchers in Engineering in the world.